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INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

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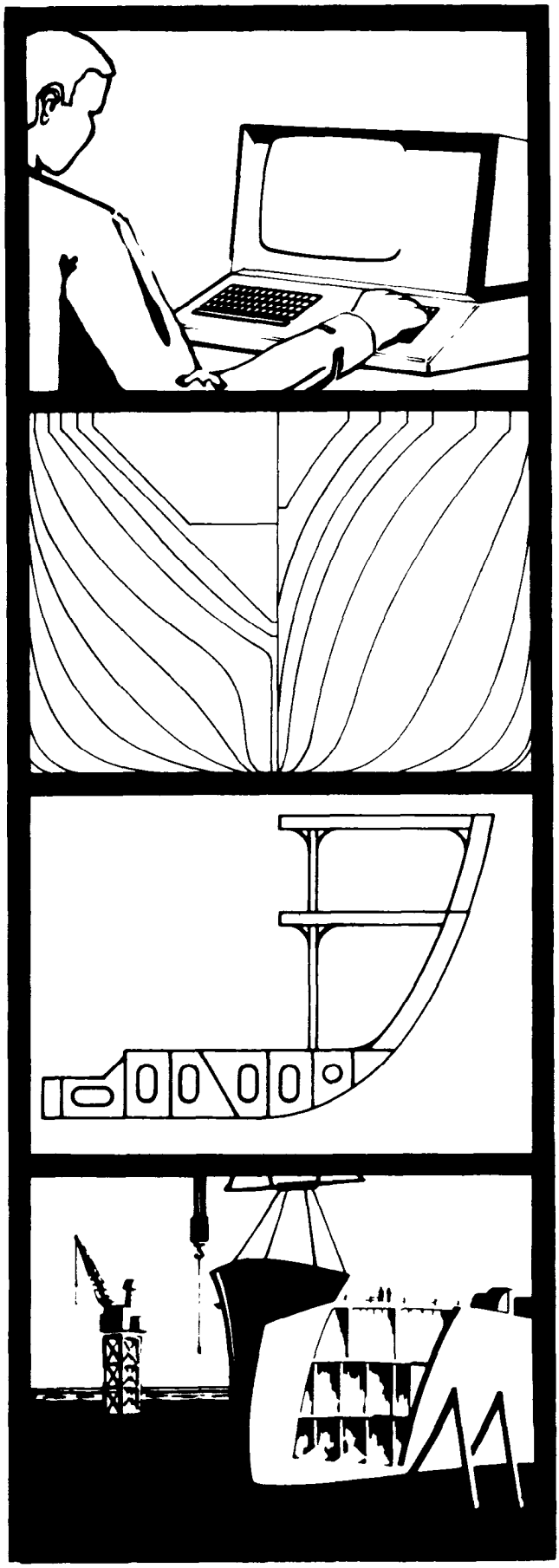

R ESEARCH
AND
E NGINEERING
FOR
A UTOMATION
AND
P RODUCTIVITY
IN
S HIPBUILDING

Proceedings of the
REAPS Technical Symposium
October 14-16, 1980
Philadelphia, Pennsylvania

A NEW APPROACH TO FABRICATION DRAWINGS

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New Orleans, Louisiana

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ABSTRACT

In this paper a problem is discussed that has existed in the shipbuilding industry for many years; that is how to present to production workers fabrication drawings that are more accurate, less cumbersome and easily understood. An approach to solving this problem through use of N/C lofting software is presented and discussed.

INTRODUCTION

For many years the shipbuilding industry has recognized the fact that skilled craft workers are becoming more difficult to find.

The skilled Shipfitter of years past is practically non-existant today. This person worked with large, cumbersome detail drawings that were prepared for regulatory body approval, along with full size templates furnished by the Mold Loft, where applicable.

In order to fabricate one unit of a vessel it was usually necessary to work with several large drawings for structures such as Shell Plating, Decks, Transverse Floors, Transverse Bulkheads, Longitudinal Bulkheads and Longitudinal Girders. Since these drawings were prepared for one third to one half of the vessel, a great deal of redundant information had to be sorted out by the Shipfitter.

In order to reduce the skill level requirement of the Shipfitter several new processes have been developed such as N/C Lofting and Plate cutting. While these processes reduced the fitting and welding man hours they did not eliminate the problem of cumbersome, difficult to understand drawings which were still necessary to fabricate the structure.

In recent years several new approaches have been made to provide fabrication drawings that are easily understood by the average craft person within the industry. These drawings are generally prepared by hand and are subject to the usual error of this process.

This paper will discuss a new approach to preparation of fabrication drawings utilizing previously generated N/C Lofting information.

THE CONCEPT

The concept of developing the fabrication drawings from previously developed N/C Lofting data came about recently as a result of the needs of a new shipyard, Upper Peninsula Shipbuilding Company. This totally new facility was to employ a local work force with no prior shipbuilding experience, therefore it was imperative that the fabrication drawings be simplified as much as possible.

Working with Breit & Garcia, the design Agent for UPSCO, Cali & Associates is developing the fabrication drawings for the first vessels being constructed in the new facility at Ontonogan, Michigan. To date, approximately one third of the structural units for the Tug of a Tug/Barge combination have been constructed utilizing the N/C Lofting data and Fabrication Drawings.

DEVELOPMENT

As can be seen from the Functional Diagram, Figure 1, the development of Fabrication Drawings does not require anything exceptional or out of the ordinary within the normal operational cycle. Some additional work is required by the N/C Loft and the Design Department which will be covered in more detail further on.

The general evolution from Design to Production, as depicted in Figure 1, is as follows:

Utilizing Contract Scantling Drawings or Detail Design Drawings the Production Department decides on the Unit breakdown, erection sequence, and welding details for

the vessel. This information is relayed to the Design Department for inclusion on drawings as necessary.

(Figure 2)

The Design Department adds erection information to the drawings such as butts, seams and welding details as required by the Production Department, for subsequent issue to the N/C Loft.

(Figure 3)

The N/C Loft, utilizing Scantling or Detail Drawings issued by the Design Department along with written planning information from the Production Department, produces all the individual parts, templates, nest tapes, stiffener data and Bills of Material required for each defined structural unit.

(Figures 4 & 5)

Upon completion and validation of all parts within a Unit, the N/C Loft prepares the background fabrication drawings utilizing the previously defined parts and a feature within the "SPADES" software that allows these parts to be drawn in their proper relationship to each other, since they have been defined within the ship's coordinate system. These drawings, by virtue of the parts having been programmed to include labeling, have all the required piece mark identification as well as reference lines and orientation.

(Figure 6)

A recently added. feature of the "SPADES" software allows the direct generation of a panel drawing for flat rectangular parts with all identification labeling, locating dimensions for attaching structure and check dimensions for alignment checks. Dimensions are all provided by the system, from the Data Base, and not from input by the part programmer. This assures accuracy and control of the data provided to the Production Department.

(Figure 7)

The Design Department completes the Fabrication Drawing generated in the N/C Loft by adding welding, standard detail call-outs and any notes that might be required. This drawing is then issued to the Production Department for subsequent use of the Shipfitters in assembly of the Units.

(Figure 8)

FUNCTIONAL DIAGRAM

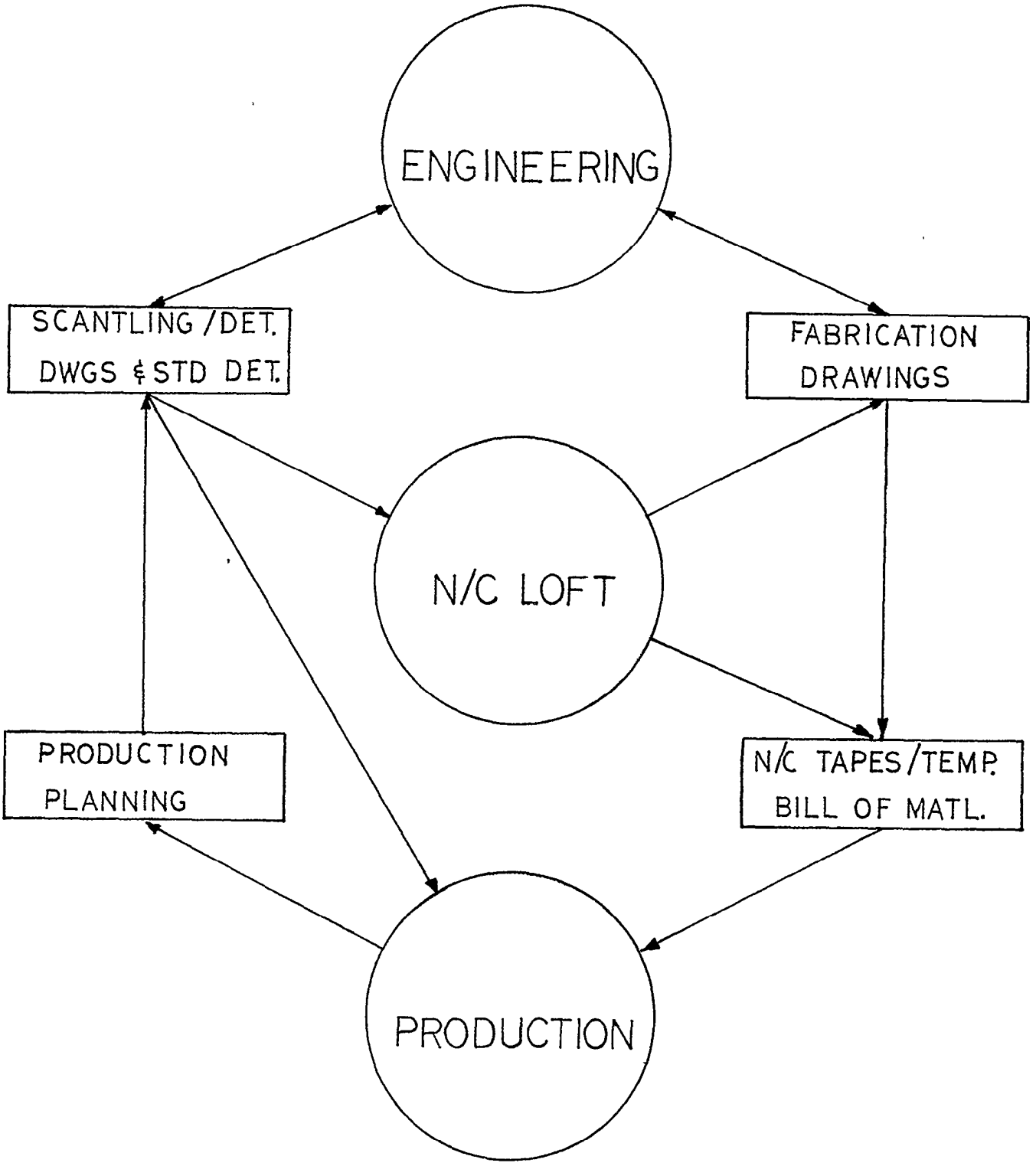


FIGURE 1

PRODUCTION PLANNING

UNIT DESCRIPTION

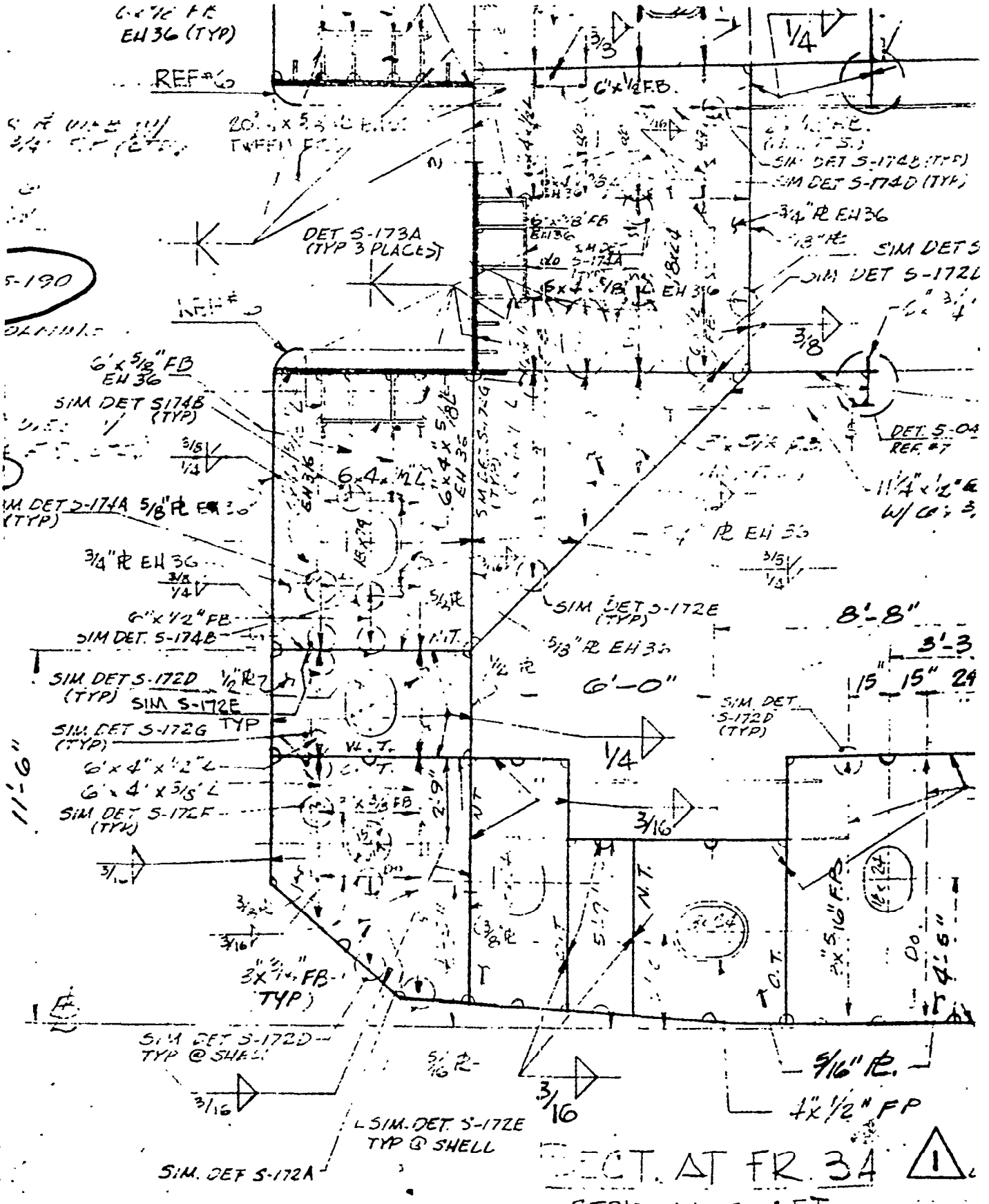
UNIT NO: 10

TITLE: WING TANK FR. 29-42 STBD.

DESCRIPTION:

THIS UNIT TO BE ASSEMBLED USING WING TANK BULKHEAD AS A BASE. PANEL WELD BULKHEAD AND ERECT FRAMES ON SAME. PANEL WELD MAIN DECK, FIT AND WELD TO PREVIOUSLY ERECTED FRAMES. FIT AND WELD SHELL PLATES, TACK WELDING ONLY TO FRAMES. ROLL UNIT ONTO SIDE SHELL AND COMPLETE WELDING DOWNHAND. LEAVE 1" STOCK ON FORWARD END OF UNIT.

FIGURE 2


EH36 (TYP)
REF #6
6"x1/2 F.B.
DET S-173A
(TYP 3 PLACES)
SIM DET S-174B (TYP)
SIM DET S-174D (TYP)
3/4" FR EH36
SIM DET S-172L
6'x5/8" FB
EH36
SIM DET S-174B
(TYP)
6x4x5/8 L
EH36
SIM DET S-172G
(TYP)
SIM DET S-174A 5/8" FR EH36
(TYP)
3/4" FR EH36
6"x1/2" FB
SIM DET. S-174B
SIM DET S-172D 1/2" FR
(TYP) SIM S-172E TYP
SIM DET S-172G
(TYP)
6'x4"x1/2" L
6'x4'x5/16 L
SIM DET S-172F
(TYP)
SIM DET S-172E
(TYP)
5/8" FR EH36
6'-0"
8'-8"
3'-3
SIM. DET
S-172D
(TYP)
11'-6"
4'-6"
3"x5/16" FB
TYP)
SIM DET S-172D
TYP @ SHELL
SIM. DET. S-172E
TYP @ SHELL
SIM. DET S-172A
5/16" FR.
4"x1/2" FP
ECT. AT FR 34
1
STBD. LKG AFT.
PORT SIDE SIM.
SCALE: 1/4" = 1'-0"

(FIGURE 3)

UPPER PENINSULA SHIPBLDG.

UFSCO TUG

NO.PLATES LIKEWISE = 1 NO.PLATES MIRROR IMAGE= 0 TOTAL NO. PLATES = 1

PLATE SIZE = 38600X 9800X 51 STOCK NO.= MTL.= STEEL

PARTS NESTED THIS TAPE

PART NO.	QTY.	PART NO.	QTY.	PART NO.	QTY.
14 60F	2/ 1	14 60F	1/ 1	14 CLR	1/ 10
14 CLR	2/ 10	14 CLR	4/ 2	14 50F	51/ 2
14 50F	4/ S 1	14 50F	4/ P 1	14 51F	4/ S 1
14 51F	4/ P 1	14 55F	4/ S 1	14 55F	4/ P 1

REVISIONS

REV	DESCRIPTION	BY	DATE

PREPARED BY

CALI & ASSOCIATES, INC.

CHECKED BY: VALIDATED BY:

JOB NO.9026UP01 NEST TAPE NO. 4610144- 3 /

FIGURE 4

IDENTIFICATION & PLOT LOCATION OF PARTS
FOR TAPE NO. 4610144- 5

PLOT REF.	DRWG. & LOC.	M/C ID & MODE	LIKE PLATE MODULE & PCMK.	MIRR. PLATE MODULE & PCMK.
1	14	0421-302- 1 L	14 60F 2/	
2	14	0421-301- 1 L	14 60F 1/	
3	14	0431- 3- 4 L	14 CLR 1/	
4	14	0431- 4- 4 L	14 CLR 2/	
5	14	0431- 2- 4 I	14 CLR 4/	
6	14	0432- 1- 2 L	14 50F 51/	
7	14	0404- 1- 5 I	14 50F 4/ S	
8		M	14 50F 4/ P	
9	14	0404- 2- 5 L	14 51F 4/ S	
10		M	14 51F 4/ P	
11	14	0404- 6- 5 L	14 55F 4/ S	
12		M	14 55F 4/ P	

*****

FIGURE 4 a

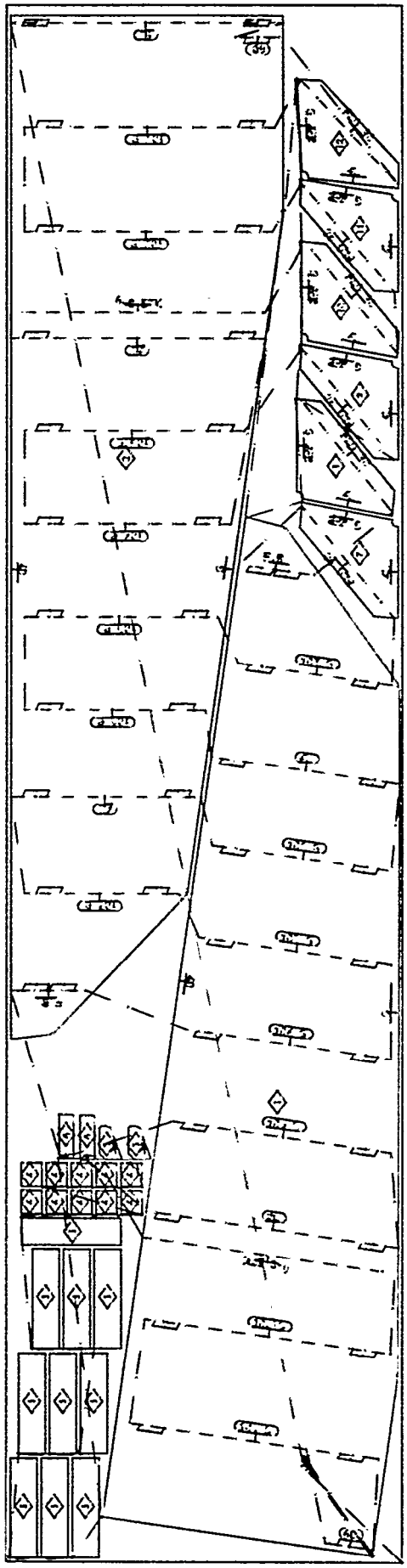


FIGURE 4 b

S P A D E S S Y S T E M DATE 10/03/80

SUMMARY REPORT OF BURNING TAPE NO. 4610144 - 3

PIERCING TIME	0.0	(PIERCING ALLOWANCE 0.0/ 0.0 MIN.)
RAPID TRAVERSE TIME	10.2	(ASSUMED SPEED 250.0 IN./MIN.)
CENTER PUNCHING TIME	5.7	(ASSUMED SPEED 250.0 IN./MIN.)
BURNING TIME	30.0	(ASSUMED SPEED 90.0 IN./MIN.)
TOTAL PROCESSING TIME	46.0	MINUTES

POST PROCESSOR OPTIONS USED FOR TAPE :

FORMAT : EIAS

CUTTING PROCESS : PLSM

PAPER TAPE PARITY : EVEN

PLATE OUTLINED BY : D.M.

KERF COMPENSATED BY AUX. FUNCTION

LABEL MARKING OFT IONS:. 11

NO OF STOPS PROGRAMMED IN THE TAPE : 4

MATERIAL UTILIZATIONS DATA

PLATE UTILIZATION = 83.9 PERCENT

SCRAP WEIGHT = 540.2 POUNDS

TYPE OF MATERIAL STEEL

FIGURE 4 c

REPORT DATE : 9/11/80 S P A D E S S Y S T E M PAGE NO. 0. 1
D.B.NAME : UP01 9026UP01 SHIP PRODUCTION AND CONTROL MODULE MODULE/UNIT: 10
VESSEL : UPSCO TUG REPORT REV. 1

TOTAL WEIGHT FOR SHAPES: 6831.7 LBS.
TOTAL WEIGHT FOR PLATES: 74252.2 LBS.
TOTAL WEIGHT FOR MODULE: 81083.9 LBS.

FIGURE 5

REPORT DATE : 9/11/80 S P A D E S S Y S T E M PAGE NO. 3. 1
D.B.NAME : UP01 9026UP01 SHIP PRODUCTION AND CONTROL MODULE MODULE/UNIT: 10
VESSEL : UPSCO TUG REPORT REV. 1

PIECES PRODUCED FROM SHAPES

LINE-REV	PIECE MARK/ DRAWING NO.	QTY/ LOC.	WGT.	MAT'L	LENGTH	STK	*A*	*B*	*C*	N/C ID	WEB 1 FLANGE 1		WEB 2 FLANGE 2		OTHER N/C DESCRIPTION	AIDS
1- 1	29F 101	2	141	OS 668	11-05-08		11-05-08			0	B	C-04	T	C-04	0	0
2- 1	31F 101	1	97	OS 668	7-10-13					0		C104		C-02	0	0
3- 1	31F 102	1	72	OS 668	5-10-06					0		C-04		C102	0	0
4- 1	31F 103	1	55	OS 670	3-05-00		3-05-00			0	B	C-04	T	C102	0	0
5- 1	31F 104	1	63	OS 670	3-11-00		3-11-00			0	B	C-04	T	C101	0	0
6- 1	31F 105	1	107	OS 670	6-07-00		6-07-00			0	B	C-04	T	C102	0	0
7- 1	32F 101	1	95	OS 668	7-08-07					0		C104		C-02	0	0
8- 1	32F 102	1	69	OS 668	5-07-10					0		C-04		C102	0	0
9- 1	32F 103	1	55	OS 670	3-05-00		3-05-00			0	B	C104	T	C-02	0	0
10- 1	32F 104	1	86	OS 670	5-04-00		5-04-00			0	B	C104	T	C-02	0	0
11- 1	32F 105	1	107	OS 670	6-07-00		6-07-00			0	B	C104	T	C-02	0	0

FIGURE 5 a

REPORT DATE : 9/11/80 S P A D E S S Y S T E M PAGE- NO. 6. 1

D.B.NAME : UP01 9026UP01 SHIP PRODUCTION AND CONTROL MODULE MODULE/UNIT: 10

VESSEL : UPSCO TUG REPORT REV. 1

PLATE MATERIAL LIST

LINE	STOCK NO.	GRADE	SIZE	QTY.	N/C-TAPE ND.	PRC.TIME	LOC.	NOTES:
1		STEEL	38600X 9800X 25	2	4610073-14	47.8		
2		STEEL	38603X 9800X 25	1	461CC78- 4	47.7		
3		STEEL	38600X 9800X 25	1	4610079- 3	44.1		
4		STEEL	38600X 9800X 38	2	4610081- 3	55.4		
5		STEEL	38600X 9800X 38	2	4610084- 3	42.1		
6		STEEL	38600X 9800X 50	2	4610089- 5	167.9		
7		EH36 STL	48000x 7400x 75	2	4610090- 6	49.3		
8		STEEL	38600X 9800X 62	1	4610091- 6	94.1		
9		STEEL	38600X 9800X 50	1	4610099- 5	156.5		
10	BEVELS	EH36 STL	48000X10200X 62	2	4610102- 4	147.1		
11		STEEL	38600X 9800X 25	1	4610103- 3	41.7		
12		STEEL	38600X 9800X 38	2	4610014- 6	146.4		
13		STEEL	38600X 9800X 38	1	4610105- 4	72.8		
14	BEVELS	EH36 STL	48000X10200X 75	1	4613106- 3	114.4		
15	REVELS	STEEL	38600X 9800X 50	1	4610108- 4	169.0		
16		STEEL	38600X 9800X 75	1	4610110- 3	79.1		
17	BEVELS	STEEL	38600X 9800X 62	1	4610111- 6	172.7		

FIGURE 5 b

REPORT DATE : 9/11/80 S P A D E S S Y S T E M PAGE NO. 7. 1

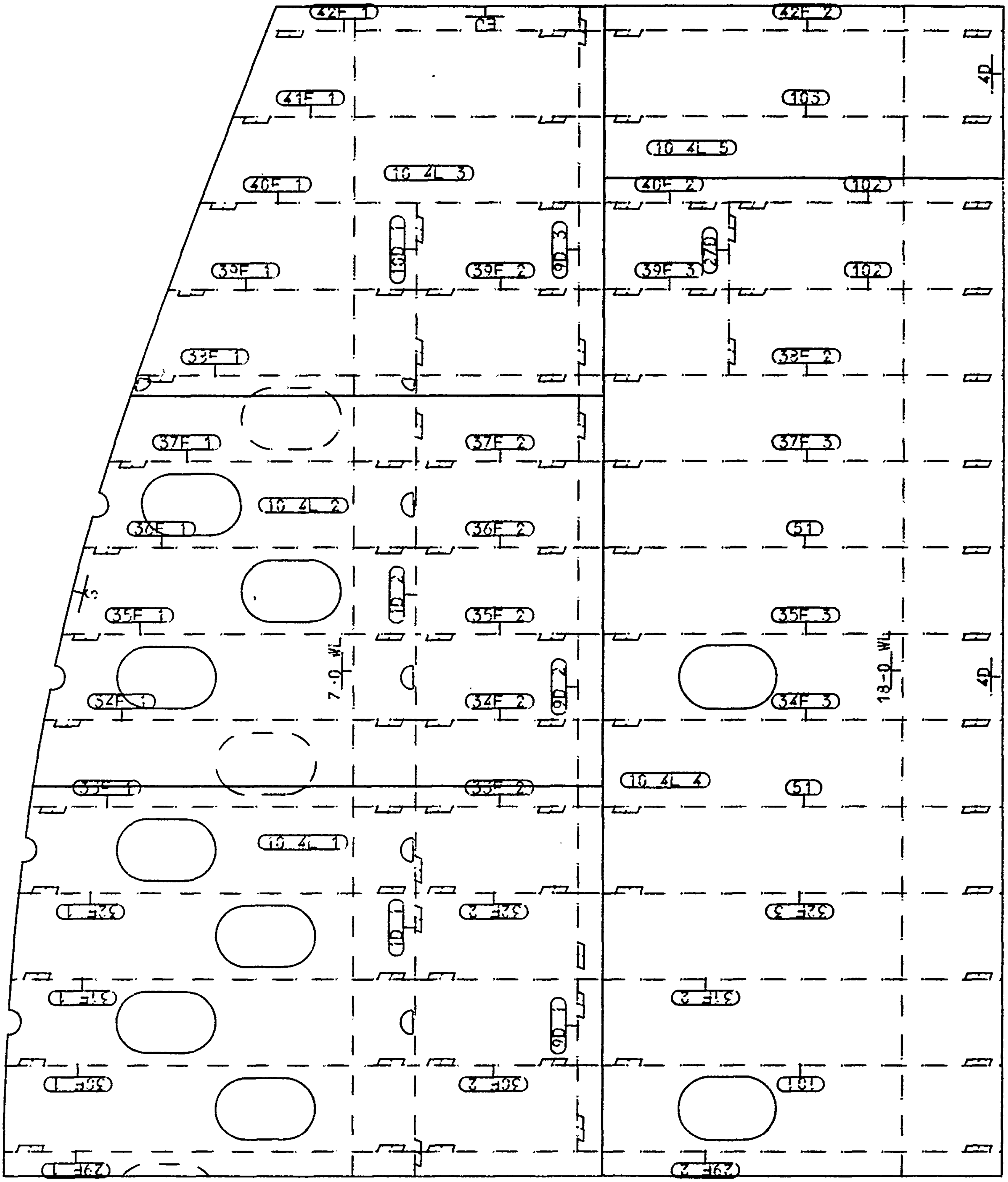
D.B.NAME : UP01 9026UP01 SHIP PRODUCTION AND CONTROL MODULE MODULE/UNIT: 10

VESSEL : UPSCO TUG REPORT REV. 1

PIECES PRODUCED THROUGH N/C CUTTING

	LINE-REV	PIECE MARK	DRAWING NO.	LOC.	QTY.	WGT.	HAT.	THK.	STK	N/C ID.	NEST TAPES	TEMPLATES	PROCESS IST	PROCESS 2ND	DESCRIPTION
	1- 1	10D 1			1	531	0	.62		0335- 1- 2	10115- 3				
	2- 1	1D 1	9-10		1	715	0	.50		0335- 2- 2	10113- 7				
	3- 1	1D 2	9-10		1	952	0	.38		0335- 3- 2	10112- 2				
	4- 1	27D 1	9-10		3	364	0	1 50		0330- 1- 4	10108- 4				
	5- 1	29F 1			1	635	0	.38		0299- 1- 2	10081- 3				
W	6- 1	29F 2			1	1034	0	.38		0311- 1- 4	10122- 6				
85	7- 1	29F 51			1	30	0	.38		0299- 2- 2	10081- 3				
	8- 1	29f 52			1	24	0	.38		0299- 3- 2	10081- 3				
	9- 1	29F 53			4	11	a	.38		0311- 2- 4	10122- 6				
	10- 1	29F 54			2	13	0	.38		0311- 3- 4	10122- 6				
	11- 1	30F 1			1	630	0	.38		0299- 5- 2	10081- 3				
	12- 1	30F 2			1	262	0	.38		0312- 1- 2	10122- 6				
	13- 1	31F 51			1	30	0	.38		0299- 6- 2	10081- 3				
	14- 1	30F 52			1	24	0	.38		0299- 7- 1	10081- 3				
	15- 1	30F 53			2	11	0	.38		0312- 2- 2	10122- 6				
	16- 1	31F 1			1	618	0	.38		0220- 1- 5	10081- 3				
	17- 1	31F 2			1	1925	3	.75		0313- 1- 3	10119- 2				

FIGURE 5 c



42F 1
CE
42F 2
4D
41F 1
105
10 4L 5
10 4L 3
40F 1
40F 2
102
39F 1
39F 2
39F 3
102
38F 1
38F 2
37F 1
37F 2
37F 3
10 4L 2
36F 1
36F 2
51
35F 1
35F 2
35F 3
7-0 WL
13-0 WL
34F 1
34F 2
34F 3
10 4L 4
51
33F 1
33F 2
10 4L 1

FIGURE 6

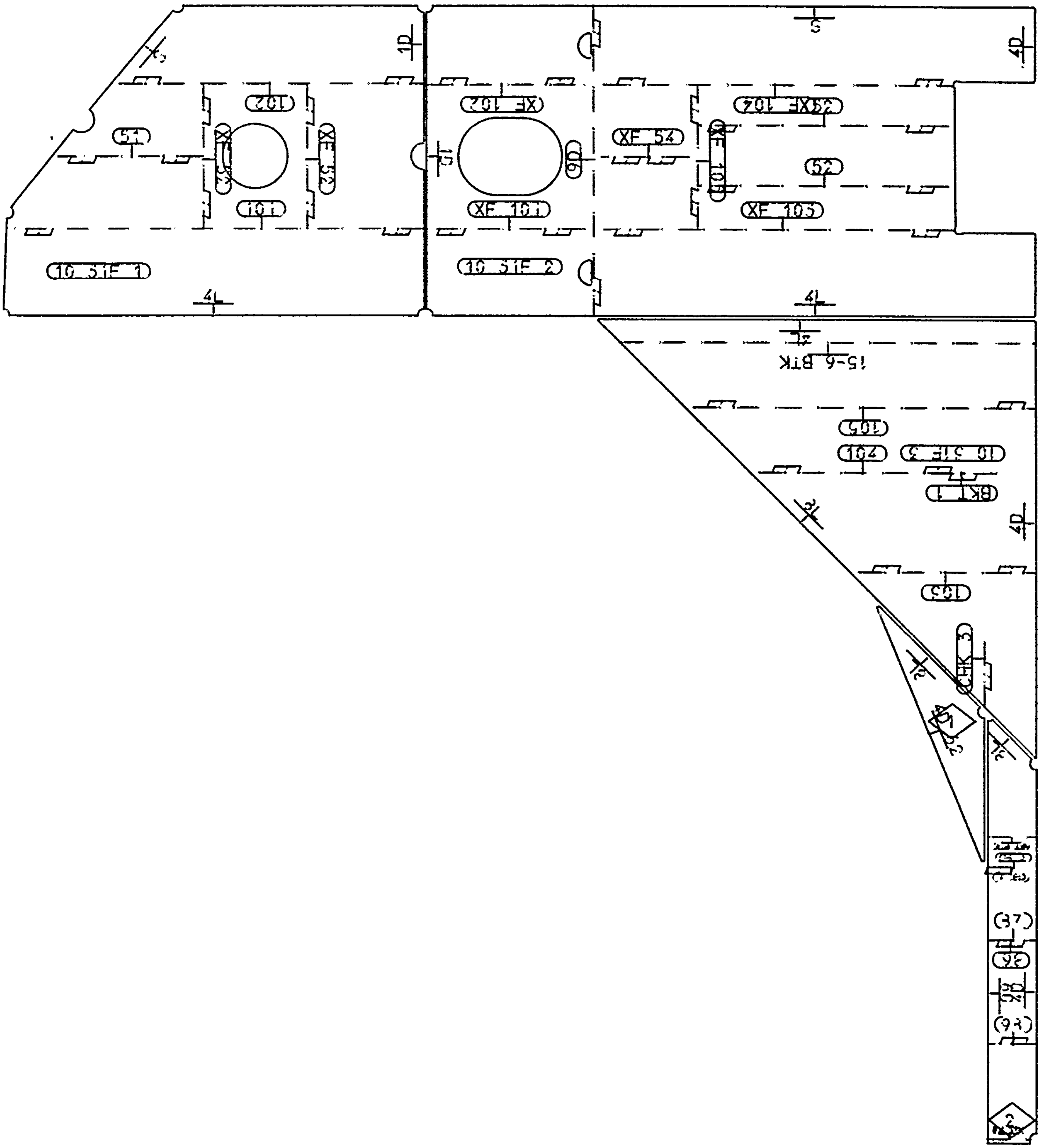

1D
5
4D
102
XF 102
XF 104
51
XF 54
52
101
XF 101
XF 105
10 STF 1
10 STF 2
4L
4L
15-6 BTK
105
104
10 STF 3
BKT 1
4D
105
37
36

FIGURE 6 a

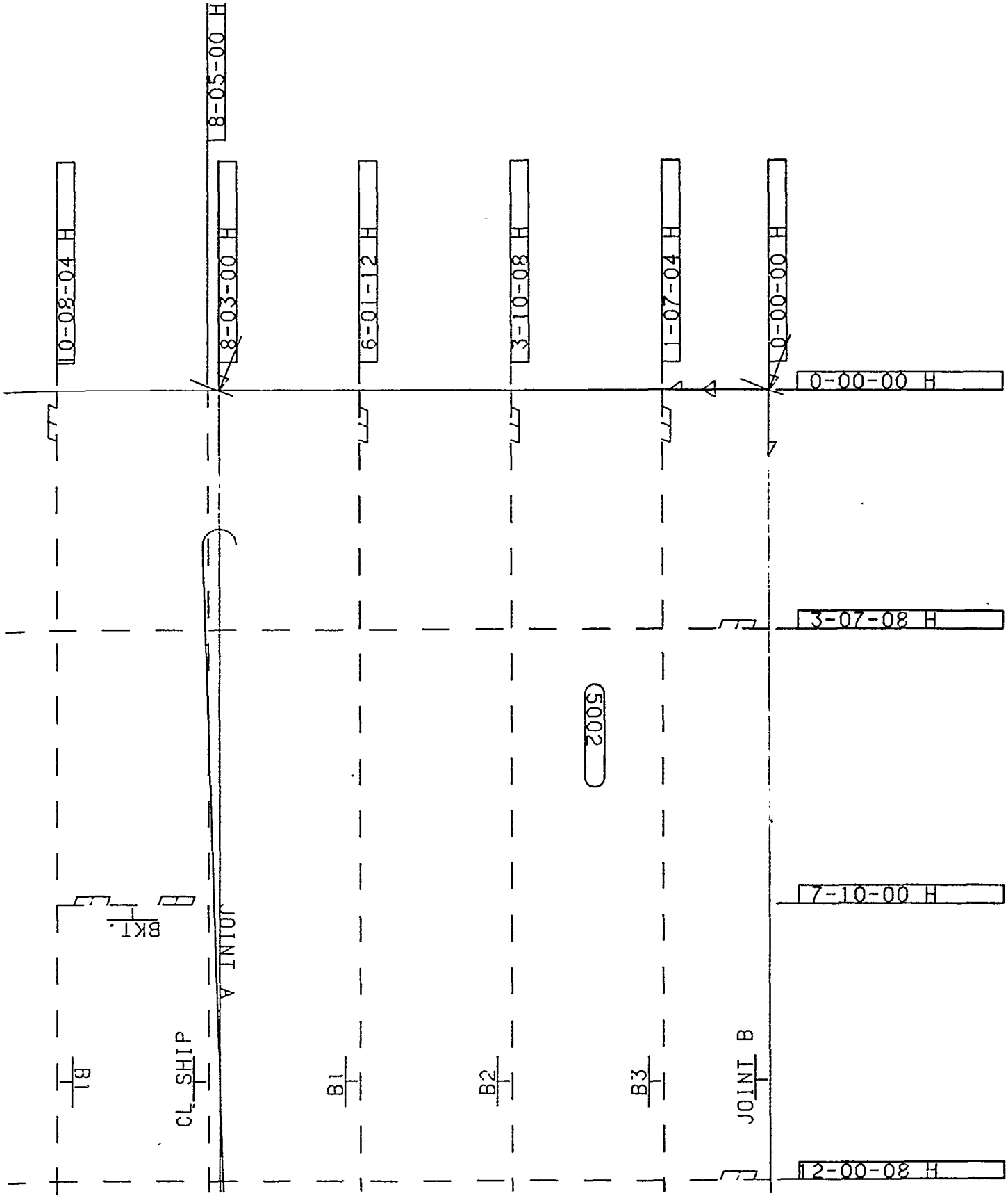

10-08-04 H
8-05-00 H
8-03-00 H
6-01-12 H
3-10-08 H
1-07-04 H
0-00-00 H
0-00-00 H
3-07-08 H
7-10-00 H
12-00-08 H
S002
BKT.
JOINT A
CL SHIP
B1
B1
B2
B3
JOINT B

FIGURE 7

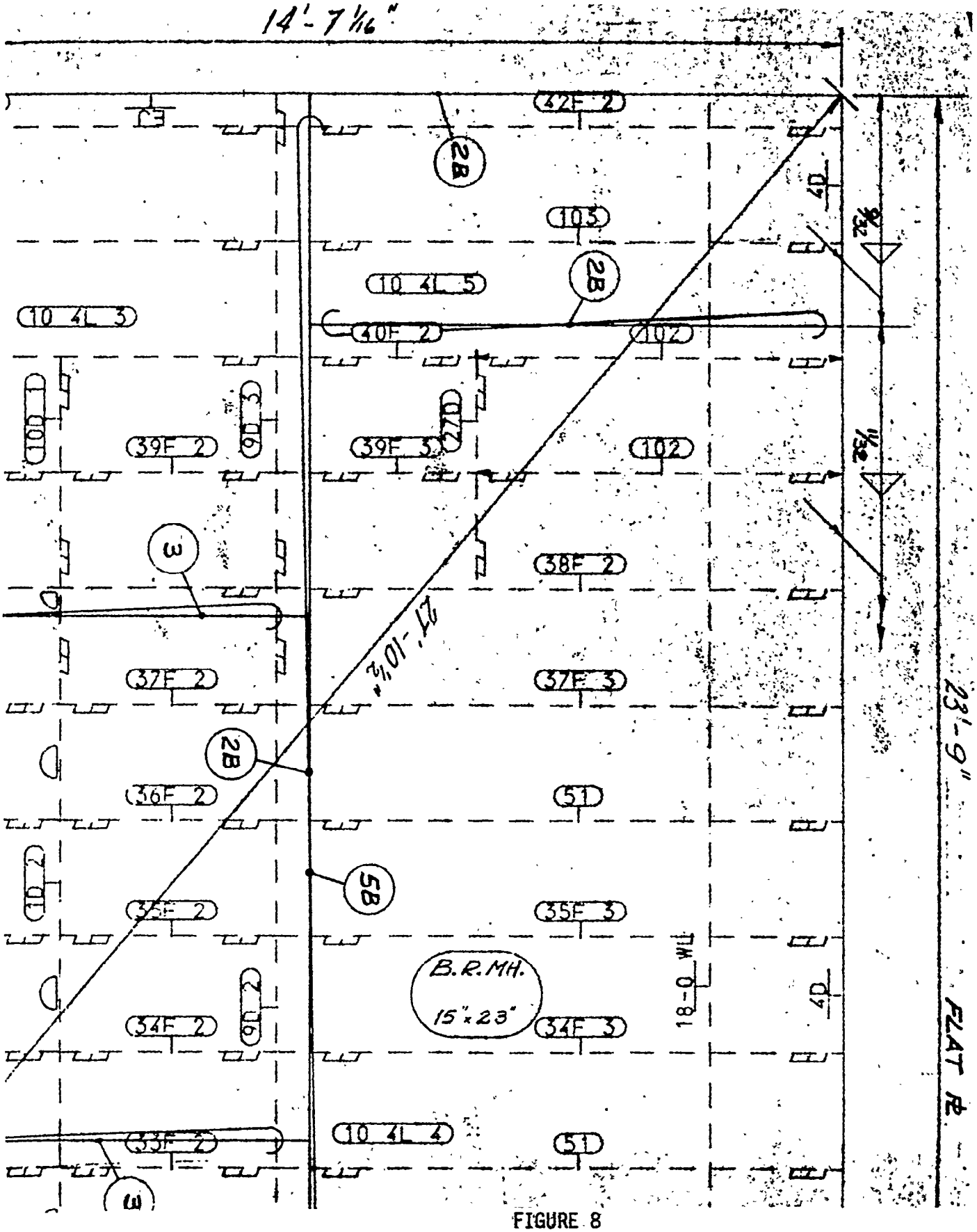

14'-7 1/16"
42F 2
2B
105
10 4L 5
2B
10 4L 3
40F 2
102
100 1
90 3
39F 2
27D
39F 3
102
3
38F 2
27'-10 1/2"
37F 2
37F 3
2B
36F 2
51
10 2
5B
35F 2
35F 3
B.R.M.H.
15"x23"
18-0 WL
90 2
34F 2
34F 3
10 4L 4
33F 2
51
3
4D
9/32
11/32
23'-9"
FLAT R

FIGURE 8

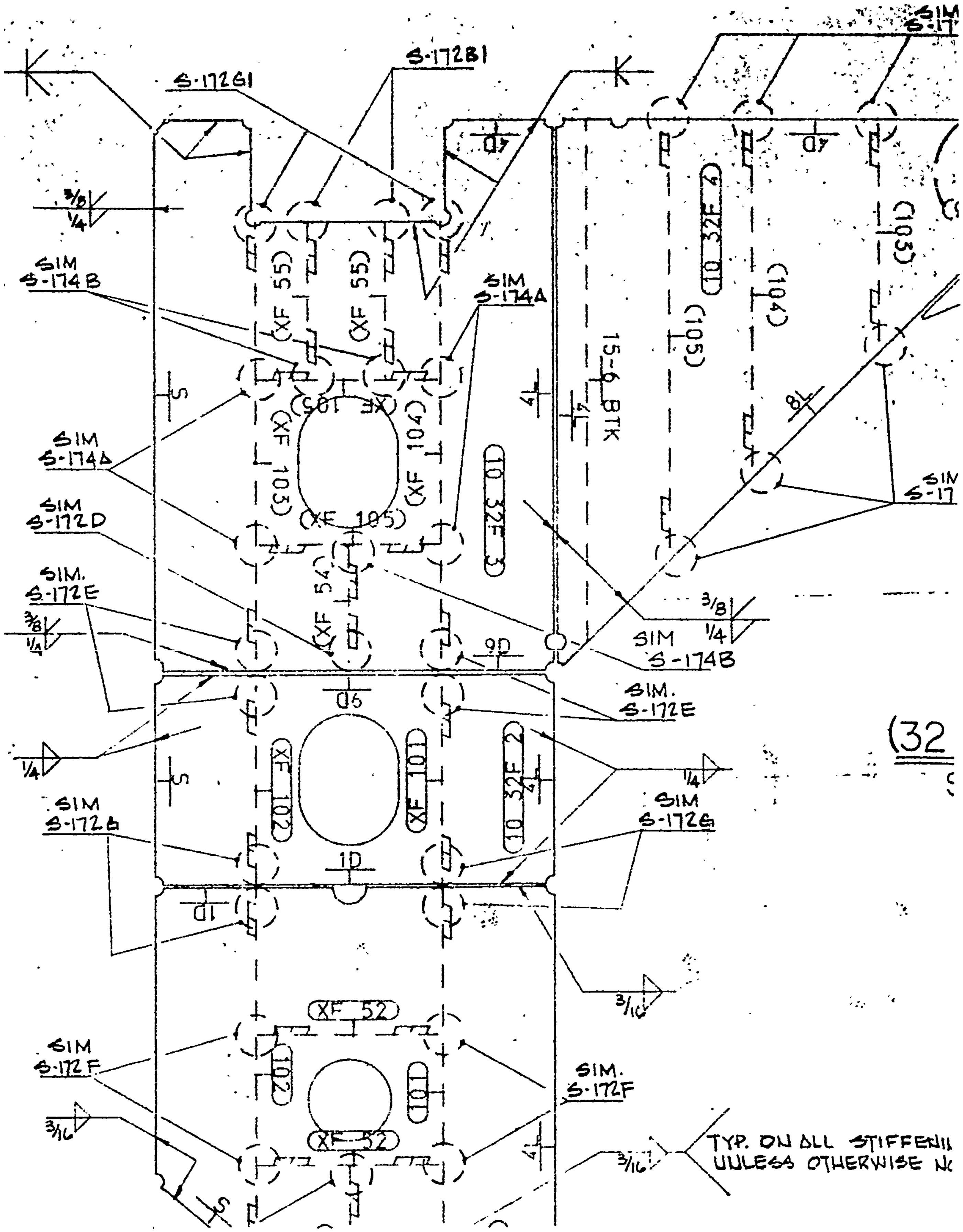

S-172B1
S-172G1
SIM S-174B
SIM S-174A
SIM S-174A
SIM S-172D
SIM. S-172E
SIM S-174B
SIM. S-172E
SIM S-172G
SIM S-172G
SIM S-172F
SIM. S-172F
(XF 55)
(XF 55)
(XF 105)
(XF 103)
(XF 104)
(XF 105)
(XF 54)
(XF 102)
(XF 101)
(XF 52)
(102)
(101)
(XF 52)
10 32F 4
10 32F 3
10 32F 2
(103)
(104)
(105)
15-6 BTK
9D
D6
1D
1D
(32
TYP. ON ALL STIFFENI
UNLESS OTHERWISE N

FIGURE 8 a

CONCLUSION

Reports from Upper Peninsula Shipbuilding indicate the Fabrication Drawings being used are a total success in that people without prior shipfitting experience are doing an excellent job in fabrication of the Tug Boat.

As experience is gained, and particularly through use of Interactive Graphics, the time to produce the Fabrication Drawings is being reduced considerably. A conservative estimate would place the cost to produce the drawings in this manner at about twenty five percent (25%) of the cost to prepare them entirely by hand.

Since the lofting effort is mandatory to the construction of a vessel, it seems that the development of Fabrication Drawings should be handled as described in this paper in order to take full advantage of the inherent accuracy and reduced man hours.